

billion (ppb). Analytical results of soil sampling at the site are discussed in **Sections 7.4.1 and 7.4.2.**

6.1.4 1998/2004 Tank 304 and 2000/2001 Tank 302 Fuel-Grade Ethanol Releases

On June 2, 2008, GES advanced ten soil borings (AM-1 through AM-10) inside Storage Area “M” for Tanks 302 and 304. Each borehole was advanced utilizing a hand auger. Soil borings were screened with a PID to provide a preliminary indication of the presence or absence of residual hydrocarbon impact to the soil.

The soil samples collected from each of the soil boring locations AM-1 through AM-10 were submitted to Accutest for laboratory analysis of BTEX, cumene (isopropylbenzene), and naphthalene by EPA Method 8260B, and ethanol by EPA Method 8015.

On October 28, 2010, GES supervised the advancement of three soil borings (AM-11 through AM-13) outside the western corner of the storage area for Tanks 302 and 304. All soil boring locations were vacuum-cleared to a depth of five feet to ensure clearance of all underground utilities. The soil borings were installed to depths ranging from 10 feet bgs to 13 feet bgs utilizing Geoprobe® direct-push drilling methods. As the borehole was advanced, soil samples were collected using four-foot acetate tubes inserted into the drilling rod and were screened with a PID to provide a preliminary indication of the presence or absence of residual hydrocarbon impact to the soil.

The soil samples collected from AM-11 through AM-13 were submitted to Accutest Laboratories of Dayton, New Jersey for laboratory analysis of PADEP Short List of regulated substances for unleaded gasoline including BTEX, MTBE, cumene (isopropylbenzene), naphthalene, 1,2,4-TMB, 1,3,5-TMB, and acetone by EPA Method 8260B; fluorene, phenanthrene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, chrysene, and pyrene by EPA Method 8270C; and ethanol by EPA Method 8015.

6.1.5 2007 Pipeline Fuel-Grade Ethanol Release

From November 5 through November 21, 2007, GES supervised the advancement of 19 soil borings (SB-1 through SB-19) on the PRPA property and office parking lot area of the Kinder Morgan property. Each borehole location was vacuum-cleared to a depth of six feet to ensure clearance of all underground utilities. The soil borings were installed to depths ranging from 16 feet bgs to 20 feet bgs utilizing Geoprobe® direct-push drilling methods. As the boreholes were advanced, soil samples were collected using four-foot acetate tubes inserted into the drilling rod and were screened with a PID to provide a preliminary indication of the presence or absence of residual hydrocarbon impact to the soil. Soil borings SB-6, SB-14, SB-11, and SB-19 were completed as monitoring wells MW-11 through MW-14, respectively, utilizing hollow-stem auger drilling methods to a depth of 15 feet bgs for MW-11 through MW-13, and to a depth of 20 feet bgs for MW-14. Boring logs for these locations are presented in **Appendix O.**

The soil samples collected from each of the borings SB-3 through SB-19 and monitoring wells MW-11 through MW-14 were submitted to Accutest Laboratories of Dayton, New Jersey for laboratory analysis of BTEX, cumene (isopropylbenzene), and naphthalene by EPA Method 8260B, and ethanol by EPA Method 8015. SB-1 and SB-2 were analyzed for benzene and ethanol only.

From May 7 through May 8, 2008, GES supervised the installation of six monitoring wells (MW-15 through MW-20) utilizing hollow-stem auger drilling methods to delineate dissolved-phase groundwater impacts observed during the November 2007 investigation of the October 29, 2007 release. Soil samples were collected from each of the monitoring well locations to further characterize soil quality in the AOC. Soil boring locations SB-2, SB-18, and SB-1 were converted into MW-18, MW-19, and MW-20, respectively.

The soil samples collected from each of the monitoring wells MW-15 through MW-20 were submitted to Accutest Laboratories of Dayton, New Jersey for laboratory analysis of BTEX, cumene (isopropylbenzene), and naphthalene by EPA Method 8260B, and ethanol by EPA Method 8015.

From October 6 through October 15, 2009, GES supervised the installation of 10 air sparge wells (AS-3 through AS-12) and nine soil vapor extraction wells (SVE-3 through SVE-11) utilizing hollow-stem auger drilling methods prior to completing system installation and trenching activities. In order to delineate impacts observed during previous investigations, soil samples were collected from two of the SVE well locations (SVE-6 and SVE-8).

The soil samples collected from each of the SVE-6 and SVE-8 locations were submitted to Accutest Laboratories of Dayton, New Jersey for laboratory analysis of PADEP Short List of regulated substances for unleaded gasoline including BTEX, cumene (isopropylbenzene), naphthalene, 1,2,4-TMB, and 1,3,5-TMB by EPA Method 8260B, and ethanol by EPA Method 8015.

From October 6 through October 7, 2011, GES supervised the installation of 11 soil borings (DA-1 through DA-11) along Delaware Avenue. Each borehole location was vacuum-cleared to a depth of five feet to ensure clearance of all underground utilities. The soil borings were installed to depths from 15 feet to 16 feet bgs utilizing Geoprobe® direct-push drilling methods. As the boreholes were advanced, soil samples were collected using five-foot acetate tubes inserted into the drilling rod and were screened with a PID to provide a preliminary indication of the presence or absence of residual hydrocarbon impact to the soil.

The soil samples collected from each of the DA-1 through DA-11 locations were submitted to Accutest Laboratories of Dayton, New Jersey for laboratory analysis of PADEP Short List of regulated substances for unleaded gasoline including BTEX, MTBE, cumene (isopropylbenzene), naphthalene, 1,2,4-TMB, and 1,3,5-TMB by EPA Method 8260B, and ethanol by EPA method 8015.

6.1.6 2010 Tank 124 Fuel-Grade Ethanol Release

On October 6, 2010, GES personnel collected two shallow soil samples (T124-G1, T124-G2) from the area beneath the release location and from an area immediately adjacent to the release location to characterize impacts to the soil from the release. Each sample was collected from the 0-6-inch interval and were analyzed for the PADEP Short List of regulated substances for unleaded gasoline including BTEX, MTBE, cumene (isopropylbenzene), naphthalene, 1,2,4-TMB, and 1,3,5-TMB by EPA Method 8260B, and ethanol by EPA Method 8015. Additionally, for waste disposal characterization the samples were analyzed for total petroleum hydrocarbons.

Benzene was detected at concentrations above the PADEP SHS MSCs for a Non-Residential, Used aquifer.

On October 25, October 26, and October 28, 2010, Lewis Environmental excavated soils from the impacted area within the Tank 124 dike area. Due to the location of the release, access was limited so the excavation was completed by hand digging soils and utilizing a conveyor system to load the excavated soils into a lined 20-cubic-yard rolloff container. Approximately 20 cubic yards of impacted soils were removed from the impacted area.

Since the soil volume that was removed during the excavation was less than 250 cubic yards (25 PA Code §250.707(b)(iii)), five biased attainment samples were required. On November 8, 2010, five biased soil samples were collected from within the excavation area (T-124 PE-1 through T-124 PE-5) to determine if the soil excavation was effective in removing the impacted soils in the area of the release. Sample locations were determined by screening the soils at the base of the excavation with a PID for the presence of VOCs. Soil samples from the five locations with the highest PID readings were collected and submitted for analysis of PADEP Short List of regulated substances for unleaded gasoline including BTEX, MTBE, cumene (isopropylbenzene), naphthalene, 1,2,4-TMB, and 1,3,5-TMB by EPA Method 8260B, and ethanol by EPA method 8015.

Two of the attainment samples (T-124 PE-1 and T-124 PE-2) had concentrations of benzene above the Soil-to-Groundwater MSC for a Non-Residential, Used aquifer. In order to address the impacts observed in the soil attainment samples T-124 PE-1 and T-124 PE-2, additional characterization in the areas of these samples was completed on January 5, 2011. Odyssey Environmental Services utilized a vacuum excavator to complete the additional soil characterization. An additional one foot of soil was removed from these locations and two additional soil samples were collected (T-124 PE-1A and T-124 PE-2A). The additional soil samples (T-124 PE-1A and T-124 PE-2A) had concentrations of benzene above the Soil-to-Groundwater MSC for a Non-Residential, Used aquifer.

Soil attainment sample results indicated that impacts from the FGE release were removed as a result of the soil excavation. There are no concentrations above the Non-Residential, Non-Use aquifer Soil-to-Groundwater MSCs at any of the attainment sample locations. Therefore, no additional characterization or remediation of soils is proposed for the October 5, 2010 FGE release. Details regarding the soil sampling and remedial actions for the October 5, 2010 FGE release were detailed in the April 4, 2011 SCR, prepared by GES, which was approved by PADEP in a letter dated July 20, 2011 (**Appendix L**).

6.1.7 2010 Tank 205 Cumene Release

On October 13, 2010, GES personnel collected five shallow soil characterization samples (T205-G1 to T205-G5) from the area beneath the release location and from areas biased towards locations expected to have the greatest impacts. These locations were selected from field screening results with a PID. Each sample was collected from the 0-6-inch interval of the clay liner and analyzed for cumene (isopropylbenzene) via EPA Method 8260B. Cumene (isopropylbenzene) was detected at concentrations above the PADEP SHS MSCs for a Non-Residential, Used aquifer in two of the samples. On January 5, 2011, approximately 16.75 cubic feet of soil was excavated from the two characterization sample locations that were above the MSCs within the Tank 205 dike area. Four soil samples were collected from the two excavation areas and results of the sampling indicated that cumene (isopropylbenzene) was detected above the PADEP SHS MSCs in all four samples. On March 2, 2011 additional soil samples were collected from the base of the clay liner to further delineate the horizontal and vertical extent of the cumene (isopropylbenzene) impacts. The results of the soil samples show that there were no

exceedances of the SHS MSC in any of the horizontal delineation samples. The vertical delineation samples had concentrations of cumene (isopropylbenzene) above the SHS MSC. Three of the samples had concentrations of cumene (isopropylbenzene) above the Direct Contact MSC for a Non-Residential, Used aquifer.

Therefore, soil sample results indicated that impacts from the cumene (isopropylbenzene) release still remain at the site. There are concentrations above the Non-Residential, Non-Use aquifer Soil-to-Groundwater MSCs and Direct Contact MSCs at two of the sample locations. However, due to the limited extent of impacts and the current and future proposed use of the impacted area, there is no further characterization and remediation proposed. Details regarding the soil sampling and remedial actions for the October 12, 2010 Tank 205 cumene (isopropylbenzene) release were described in the April 11, 2011 SCR, prepared by GES, which was approved by the PADEP in a letter dated July 20, 2011 (**Appendix M**).

6.1.8 2012 Storage Area “A-2” Fuel-Grade Ethanol Release

On April 19, 2012, GES personnel collected four shallow soil characterization samples (SS-01 to SS-04) from the area around the release location in Storage Area “A-2” and from areas biased toward locations expected to have the greatest impacts. These locations were selected from field screening results with a PID. The dike containment walls in Storage Area “A-2” are concrete structures, the containment is built to Title 25 of the Pennsylvania code, chapter 245, section 245.542 (d)(2)(ii). The clay is a 12-inch continuous layer and is covered with a layer of modified stone ranging from 0.5 feet to 1.5 feet in depth. Each sample was collected from the top six inches of the clay liner and was analyzed for BTEX, cumene (isopropylbenzene), naphthalene, 1,2,4-TMB, and 1,3,5-TMB via EPA Method 8260B, and ethanol via EPA Method 8015.

None of the analyzed compounds were detected at concentrations above the PADEP SHS MSCs for a Non-Residential, Used aquifer in the samples collected. It should be noted that due to a laboratory error, the ethanol analysis was completed out of the recommended hold time. However, since there is not a MSC established for ethanol and the analysis for the remaining compounds was completed within the recommended hold time, additional samples were not collected. Details regarding the April 4, 2012 FGE release and associated soil sampling were detailed in the August 31, 2012 SCR, prepared by GES, which was approved by PADEP in a letter dated October 9, 2012 (**Appendix N**).

7.0 SITE INVESTIGATION RESULTS

This section presents a comprehensive summary and discussion of the data that were collected during the various investigations conducted at the site. More specifically, this section discusses: the site hydrogeology; observations of SPH origin and extent; laboratory analytical results for samples collected from soil and groundwater; and the results of an ecological screening assessment.

7.1 Local Hydrogeology

As stated in **Section 5.0** (Site Characterization Activities – Groundwater), a number of activities have been conducted to investigate the hydrologic/hydrogeologic conditions at the site, including groundwater elevation monitoring and the completion of a tidal study. The results of these activities and the interpretation of the hydrogeologic conditions at the site based on these results are discussed in the following sections.

7.1.1 Groundwater Elevation Monitoring

Periodic groundwater monitoring was initiated at the site in 2008, and quarterly groundwater monitoring has been conducted at the site since 2010. This monitoring has included the measurement of groundwater elevations at all existing monitoring wells. All groundwater elevation measurements collected by GES at the site to date are presented in **Table 2**, which is organized by well and then by chronological order of the sampling event occurrence. The data presented in this table were used to develop a conceptual understanding of the groundwater flow regime present beneath site, which is discussed below.

Using the September 4 through September 6, 2012 and December 3 through December 6, 2012 gauging data collected from Kinder Morgan's Philadelphia Terminal, comprehensive gauging maps were compiled (**Figures 5 and 6**).

Review of **Figures 5 and 6** indicates a general northeasterly flow direction across the western portion of the site. Groundwater flow direction across the southeastern part of the site is in a general easterly flow direction. Conversely, flow direction across the central and northeastern portion of the site is in a general northerly direction. It should be noted that the City of Philadelphia sewer line that is present on the site appears to influence groundwater flow across the central and northern portions of the property.

Gauging of the monitoring wells on the southeastern property boundary and the PRPA property indicates a general southerly flow direction, towards the Delaware River. The PRPA gauging data, along with the northerly flow direction across the central portion of the site creates a groundwater divide on the southeastern portion of the Kinder Morgan Philadelphia Terminal.

7.1.2 Tidal Study Results

As previously discussed in **Sections 2.3.4 and 5.3**, in order to determine whether the groundwater in the monitoring wells at the site are tidally influenced by the Delaware River, a tidal influence study was conducted from September 20 through September 27, 2010.

Programmable data loggers with pressure transducers were utilized to record water level measurements every fifteen minutes. Transducers were placed in seventeen monitoring wells (MW-3B, MW-5A, MW-5B, MW-6B, MW-7B, MW-8, MW-13, MW-17, MW-19, MW-20,

MW-23, MW-25, MW-31, MW-34, MW-37, MW-39, and MW-40) and water level measurements were collected over a one-week period. Additionally, tidal data from the Delaware River was obtained from www.tidesandcurrents.noaa.gov in order to compare the tidal cycle in the adjacent surface water body to any changes in elevations observed in the site monitoring locations.

In general, the graphs for the monitoring wells on the Kinder Morgan side of Delaware Avenue do not identify any synoptic groundwater elevation changes. However, the graphs for the monitoring wells located on the PRPA property did show synoptic trends. The tidal study graphs are included as **Appendix P**.

The results of the tidal study indicated that water levels in the onsite monitoring wells do not vary on a semi-diurnal tidal cycle, while the offsite monitoring wells located on the PRPA property do show a response to the tidal cycle in the Delaware River. The tidal response in monitoring wells located on the PRPA property ranged from less than 0.1 feet (MW-19) up to 0.5 feet (MW-23).

7.2 Separate-Phase Hydrocarbon (SPH) Recovery

A number of activities have been conducted at the site to investigate SPH extent and origin, including SPH fluid level monitoring and laboratory forensic analysis, respectively. The results of these activities are described in the following sections.

7.2.1 SPH Extent

Groundwater monitoring has been conducted at the site by GES since 2008. Since investigation activities were initiated at the site, SPH accumulations have been observed in a total of 2 monitoring wells (TP-4 and MW-29). SPH were not detected in monitoring well MW-29 until the March 2011 groundwater monitoring event. All liquid level measurements that have been collected at the site to date are presented in **Table 2**, which is organized first by well, and then by the chronological order of the sampling event occurrence.

Review of **Table 2** indicates that the extent of the SPH plume has decreased since the initial monitoring event completed in 2008, due to active SPH recovery from TP-4 (as discussed in **Section 7.2.3**), and that presently there are no monitoring wells that contain a measurable thickness of SPH.

7.2.2 SPH Forensic Analysis

SPH samples were collected from TP-4 and submitted to Worldwide Geosciences, Inc. for chemical forensic characterization. The results of the analysis showed the following:

- The SPH present in sample TP-4 contained mostly benzene and cumene (isopropylbenzene). The concentrations of each were believed to be from individual constituents and not indicative of a standard petroleum product.

A more detailed discussion of the forensic characterization can be found in the Worldwide Geosciences report presented in **Appendix R**.